THE IMPORTANCE OF LOCAL ECOLOGICAL STUDIES TO ENTOMOLOGY.[1]

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In the study of geographical distribution, all realize in a general way the great changes which have taken place over the entire country since America was settled by white men. The destruction of the forests by the axe and fire, the clearing and cultivating of the land, the diminution and pollution of the streams, the draining and filling of swamps, the construction of reservoirs and dams and extensive mining operations, all tend toward changing physical conditions governing the existence and distribution of the flora and fauna.

How frequently we hear complaints of the inadequate data kept by the early naturalist, of species now practically extinct. Here we might ask these questions: Are we keeping requisite data for future investigators? Are we taking into account the local changes which have taken place, and are continually taking place, and their effect upon the fauna and flora? These changing conditions, which have so long appealed to the mammalogist, the ornithologist and botanist, have either been ignored, or only touched upon lightly by entomologists. It is not often intentional on their part, for entomologists have a great deal to do. Then too there are so many insects, and species are often so widely distributed, that when they become scarce in one section they can so readily be obtained from another, that local conditions affecting certain species are easily overlooked.

In entomology there are other factors besides changes in physical conditions to consider, among which are the introduction of injurious insects through commerce and otherwise, followed by the introduction of their parasites to aid in keeping them in check. One naturally asks what will be the effect of the introduced parasites on the indigenous species. When these parasites are established, will they infest the native species and perhaps locally exterminate them? This seems to be the solution of the extermination of *Pontia oleracea* in many parts of New England after the introduction of *Apanteles glomeratus*, the parasite of the European cabbage butterfly (*Pontia rapae*). Another factor is the extensive cultivation of trees and plants far beyond their natural limits, thus enabling the insects feeding upon such

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plants to extend their range of distribution. A noticeable illustration is the spread of the Catalpa sphinx (*Daremma catalpae*). The catalpa, which is a native of the southern States, has now become a common shade tree throughout the northern states. The sphinx, which has now reached New York, first made its appearance in the vicinity of Philadelphia in 1898, doing considerable damage. The following year it was more abundant and an interesting feature in this connection is that at that time it apparently had no natural enemy, but in 1900 parasites appeared which destroyed fully eighty per cent of the larvæ. It was therefore evident that the moth, in its migration northward, advanced more rapidly than its parasites, or was for the time immune. It would also be well to consider the effect of the attacks of native insects on foreign plants.

Geographical distribution from an ecological standpoint, presents a most fascinating subject, made doubly interesting by its great diversity and many intricacies. Especially is this true of insects and particularly so in New England, where the varied surroundings within a comparatively small area, present many of the conditions which undoubtedly governed and limited the early dispersal of species. The birds and mammals have been mostly used in defining faunal areas, and while the areas thus defined represent what might be called the greater life zones, they are often too general in character to account for many of the unexpected appearances and peculiar variations of certain insects. A thorough ecological study of a given area will, no doubt, account for many if not all of these unusual occurrences, or add materially to our knowledge governing the conditions affecting the distribution of insects.

A brief history of geographical distribution bearing on New England, shows the characteristic progress which has attended all lines of scientific research. It was Prof. Louis Agassiz who in 1854 (in Nott & Gliddon, Types of Mankind), first attempted to divide North America into several zoological areas. On the Atlantic coast he recognized four — the Arctic, including Greenland and Labrador; the Canadian extending from Labrador south to a line drawn across the centre of New Hampshire and Vermont; the Alleghenian embracing all the region from southern Maine to North Carolina, and the Louisianian from southern Virginia to southern Florida. In 1859 Dr. John L. LeConte (Smith. Contr. Knowl., XI) divided the United States into a number of provinces, the first attempt made from an entomological standpoint, and based on the distribution of Coleoptera. In making these divisions he says: The whole region of the United States is divided by meridional or nearly meridional lines into three or perhaps four great zoological districts, distinguished each by numerous peculiar genera and species which, with but few excep-

tions, do not extend into the contiguous districts. .... These great districts are divided into a number of provinces of unequal size, which are limited by changes in climate and therefore sometimes distinctly, sometimes vaguely, defined. The Atlantic district may be divided into — a northern province, including Maine, Eastern Canada, Nova Scotia, Newfoundland, etc.; a middle province limited westwardly by the Appalachian chain and extending to southern Virginia; a southern province, including the States south of Virginia and Kentucky, and a subtropical province including the point of the peninsula of Florida.

In 1863 Prof. A. E. Verrill (Proc. Boston Soc. Nat. Hist., X, 260) made the dividing line between the Alleghenian and Canadian "coincident with a line which shall indicate a mean temperature of 50° Fahrenheit during the months of April, May, and June." In describing its course he says: — "It passes south of Moosehead and Umbagog Lakes, but rises somewhat northward along the Androscoggin valley, thence it passes southward of the White Mts. through the vicinity of Conway, N. H. It then bends northward again up the Connecticut valley as far as Craftsbury, Vt."

In 1871 Prof. J. A. Allen (Bull. Mus. Comp. Zool., II) in describing the northern boundary of the Alleghenian fauna says: —The line follows the northern boundaries of the low lands through southern Maine and southern New Hampshire. In the Connecticut Valley it rises farther to the northward and in its southern descent skirts the eastern base of the Green Mts." Both Verrill and Allen based their conclusions upon the study of birds during breeding season.

The next paper to consider is that exceedingly interesting chapter by Mr. Scudder on the distribution of insects in New Hampshire (in Hitchcock's Final Rept. on the Geol. of N. H., vol. I, chap. xii, 1874). Although only two groups are considered — the butterflies and grasshoppers — two which are perhaps the best to start with, he points out very clearly the many conditions governing their distribution, as follows:— "Since insects are not regularly migratory animals; as several generations frequently succeed each other during a single season; and, as the winter is passed in very various conditions, we can hardly expect their distribution to follow exactly that of birds. Various causes may modify unequally the distribution of insects belonging to a certain group: too intense cold in our arctic winters; the lack of snow during a less severe season; too excessive or too long a drouth in midsummer; or too sudden changes of temperature at critical periods. Taking our butterflies only, they may be found at every season of the year, even in midwinter, of one species or another, in every stage of existence, from the egg through all the larval periods and the chrysalis to the imago. The distribution of butterflies is therefore much more complicated than that of birds, whose early stages are always passed in com-

paratively warm weather, under the guardianship of the mother; and, if more than one brood appears during a season is only the produce of the same pair that raised the first." Mr. Scudder also refers to the effect of elevation, defining the subalpine and alpine areas of Mt. Washington.

In 1888 Prof. Wm. M. Davis and Mr. Scudder published a map showing the isothermal lines and faunal areas of New England. A modification of this map in which the areas defined as the "Ordinary southern limit of the Canadian" and the "Ordinary northern limit of the Alleghenian" fauna are united to form the Transition, leaving the restricted Alleghenian to constitute the Upper Austral, represents practically the present faunal zones as defined by Dr. C. H. Merriam, except that the whole Cape Cod region would be included in the Upper Austral, a feature which, from an entomological standpoint will probably prevail, and which is strengthened by a study of the distribution of New England locusts by Mr. A. P. Morse (Psyche, VIII, 315, 1899). In this paper the limits of the Upper Austral are locally increased. An area extending northward from Narragansett Bay to the Valley of the Merrimack near Lowell, and north almost to Manchester, N. H., is termed the "Dilute Carolinian locust fauna." From a Dipterological standpoint this is especially interesting as I am not only finding a number of Upper Austral but even Lower Austral species in this area.

In taking up the subject of insect distribution in New England, a region which was covered with ice during the glacial period, we must first consider the supposed source of the present fauna. The southeastern United States has been designated by Mr. C. C. Adams (Biol. Bull. III, 125, 1902) and others, as the probable centre of geographical distribution of the flora and fauna of the eastern United States, from which radiated the three primary paths of dispersal — the Mississippi valley, the coastal plain, and the Appalachian Mountains and adjacent plateau, the coastal plain being finally occupied by forms now placed in the Upper and Lower Austral, the former extending along the New England coast at least as far as Cape Cod and Plymouth if not farther, and up the Connecticut valley to Springfield. The Transition, which in the southern and middle states is confined to the more mountainous portions, spreads over the greater part of New England, leaving the Green Mountains, the White Mountains northward, and the northern half of Maine in the Boreal zone.

In further pursuing the subject of life zones we can look upon the boreal as receding, losing perhaps more from the despoliation of our forests and the results thereof, than either the Transition or Austral. There is, on the other hand, a natural tendency for insects to migrate northward. This is exemplified by the spread of the Brown-tail Moth which has extended to Nova Scotia, while to the southward it has

scarcely reached Connecticut; the Leopard Moth (*Zeuzera pyrina*), which has spread from the vicinity of New York city to Danvers, Mass.; the Harlequin Cabbage-bug (*Murgantia histrionica*), which has migrated from Mexico to Long Island, N. Y.; the two asparagus beetles, *Crioceris 12-punctata*, which is now found in Milton, Mass.; *C. asparagi*, which has reached New Hampshire; and many other species. These advances northward, however, by many species of the Transition and Austral zones may in part be only temporary, an unusually cold winter destroying the invaders. It has been shown by Prof. E. Dwight Sanderson, in a paper on "The influence of minimum temperatures in limiting the northern distribution of insects" (Jour. of Economic Entom. I, 245, 1908) that a temperature of —24° F. will practically check the northern spread of the Brown-tail Moth. The northern limit of the asparagus and elm beetles "agrees quite closely with the average annual minimum isotherm of about —10° F." Prof. Sanderson also points out that the present Upper Austral zone of Doctor Merriam does not extend far enough northeast.

I now wish to consider some of the minor or local features bearing on distribution. In the maritime area, in which is included the fauna of the immediate coast line, and on which the limitation of the Upper Austral is partly based, we have a number of species even north of Cape Cod which are not only common in the Upper Austral, but in the Lower Austral as well. Among the Diptera might be mentioned *Chrysops flavidus* and *C. plangens* from Maine to Florida, *Tabanus nigrovittatus*, the common "greenhead" from Nova Scotia to Florida, *Odontomyia microstoma*, from New Hampshire to Maryland, *Culex sollicitans* (the "Salt Marsh Mosquito") from Maine to Florida and even in Jamaica; *Stichopogon argentea* among the sand dunes from Maryland to Massachusetts; *Hypocharassus pruinosus* from St. Augustine, Fla., to Cohasset, Mass.; *Triodonta curripes* from Cape May, New Jersey, to Nova Scotia; *Phyllogaster cordyluroides*, Florida to Massachusetts; *Chaetopsis apicalis*, Ormond, Fla., to Cohasset, Mass., and *Caenia spinosa*, Florida to Massachusetts. In the other orders I can only mention a few of the more conspicuous: *Elis quadrinotata*, *E. plumipes* and *Microbembex monodonta* in the Hymenoptera; *Cicindula dorsalis*, *Strategus antaeus*, *Saprinus pennsylvanicus*, *S. patruelis* and *Phaleria testacea* in the Coleoptera; *Junonia coenia*, *Callidryas eubule*, *Terias nicippe*, *T. lisa* and *Eepantheria scribonia* in the Lepidoptera, and the salt marsh dragon-fly, *Micrathyria berenice*, all common insects in Florida which are also found in Massachusetts.

The distribution of one insect often governs the distribution of another, thus we find even at the most northern limit of distribution in New England of the Carpenter bee (*Xylocopa virginica*), its parasite, *Spogostylum simson*.

Another interesting feature in this Austro-transition area is the distribution of the three principal broods of the Periodical or Seventeen-year Cicada (*Tibicen septendecim*). Whether the different geological formations have any bearing in the matter I cannot say. Brood XI (1920) which occurs only in New England, and which I am sorry to say has been almost exterminated, owing to the clearing of the woodlands, is (or was) confined chiefly to the Triassic area of the Connecticut Valley, with two small colonies in or near the Narragansett basin. Brood II (1911), distributed throughout eastern Pennsylvania, New Jersey and southern New York, is confined principally to the granitic area of western Connecticut. Brood XIV (1923) which is confined to the Tertiary of the Cape Cod region extending northward almost to the town of Plymouth, seems to have reached New England by way of Long Island. It is also interesting to note that of the five broods occurring in New England, no two broods occupy the same area, as sometimes occurs further south.

On the coast of Maine there is an opposite condition to that of Massachusetts, the cold water and humidity presenting favorable conditions for many boreal trees and plants as far south as Mt. Desert and even to Casco Bay, which in turn foster many boreal insects.

An important factor and one which enters into the distribution of insects, is the relation of the geological formation of the soil to plant distribution. This is not as yet defined sufficiently to be of great value entomologically, but entomologists as well as botanists, should carefully consider this matter. In New England, even moderate elevations have a more noticeable effect on vegetation than further south. In New Hampshire Prof. C. H. Hitchcock (Geol. N. H., Vol. I) states that chestnut and white oak follow quite closely the contour of 600 feet. His map illustrating this feature, shows a long narrow strip varying slightly in width, extending south from the White Mts. into Massachusetts. It is a gneissic or granitic area, forming the water shed dividing the tributaries of the Connecticut from those of the Merrimack river. The numerous peaks, some exceeding 2000 feet, and cold springs, the sources of the numerous streams, provide conditions governing the flora and insect fauna. This upland area together with numerous local situations, such as cold swamps, constitutes the source of many boreal species that appear in what is considered the Transitional zone.

The relation of the flora to the abundance and distribution of insects, is not fully appreciated by the majority of entomologists. The two are inseparable, and in preparing faunal lists a knowledge of the food plant and condition under which the larva exists goes far toward solving many problems. The various oaks are preyed upon by a larger number of species of insects than perhaps all of the other hard-

wood trees. Packard in 1890 recorded over 500 species of all orders as injurious to the oak in the United States, and says that ultimately the number may even reach 1000. About 170 species infest the hickories, 40 the locust, 80 the elm, 100 the different species of maples, over 100 the various birches, 40 the beech, 130 the wild cherries, plums, thorns, etc., 45 the ash, 60 the linden, 100 the poplars, 225 the willows, 50 the alder, 35 the hazel, 170 the pines, 80 the spruces and fir, and 60 the larch and junipers. Add to these the army of dependent parasites, and we have a very forcible illustration of the flora as a factor in the distribution of insects.

The first list of New England insects was that published by Harris in 1833 in Hitchcock's Report on the Geology, Botany and Zoology of Massachusetts. This was revised in 1835 in a second edition of the same work. The list contains 2350 species, most of these having been collected in the vicinity of Boston. The relation of insects to plants, was fully appreciated by Harris, although it would be rather difficult, even at this time, to give a ratio. In closing his remarks he says: — "The proportion of insects to plants has been stated to be six species of the former to one of the latter. The flowering plants of Massachusetts amount to above 1,200 species, hence our insects cannot be much less in number than 7,000 species." It is not a bad estimate for that time, considering that we now estimate the number in New England at 11,000, but his number of plants was entirely too low, and his ratio on the present number of plants would give Massachusetts over 12,000 species.

There are comparatively few local faunal lists of New England insects to aid in working out many of the interesting features in geographical distribution. In 1874 Mr. E. P. Austin (Proc. Boston Soc. Nat. Hist., XVI, 265) published a "Catalogue of the Coleoptera of Mt. Washington, N. H.," followed by a list of additional species by Mr. F. Gardiner, Jr., in 1877 (Psyche II, 211). The two lists contain 314 species. In 1894, Mrs. A. T. Slosson commenced a "list of the insects taken in the alpine region of Mt. Washington." Additions to the list have appeared at various times up to November, 1906, the total number recorded being 2208 species, including 628 Coleoptera, 628 Hymenoptera, 599 Diptera, 119 Lepidoptera and 122 Hemiptera. While the species recorded were all taken in the alpine region, it is not in its entirety a list of the true alpine species, for strong winds frequently carry there large numbers of insects from the lower levels. Miss Mattie Wadsworth (Ent. News I–V) has listed 57 species of Odonata from Manchester, Me., a good local list considering that Dr. Calvert's list gives 140 for New England.

There is now in progress a great deal of work along the lines of distribution. Dr. W. E. Britton is at work on the insect fauna of Connecticut, Mr. N. S. Easton has just finished a list of 1019 species of Coleoptera collected within ten miles of the

city hall of Fall River, Mass., Dr. George Dimmock is making a card catalogue of the fauna of the middle Connecticut valley, Mr. S. A. Shaw is making a careful study of the fauna at Hampton, N. H., while a number of entomologists in Maine are doing excellent work. The members of the Cambridge Entomological Club are also hard at work, but we have a task before us more difficult than simply collecting. We are on debatable faunistic ground. We are in the midst of a war on the Gypsy and Brown-tail moths, the continued work on their suppression will undoubtedly reveal many changes in local conditions. It seems therefore essential that our local work should be the best, and that the importance of this matter be fully appreciated.

MELANOPLUS HARRISII N. SP.

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Closely resembling *M. phoetaliotiformis* of northern California but a little smaller and distinctly more slender, especially in the hind femora, the face more retreating and the abdomen more strongly keeled above.

Facial costa narrow, only equalling width of basal joint of antenna. Face deep plumbeous, brownish above, lacking the luteous tints of *phoetaliotiformis*. Top of head and pronotum without pale markings. Sides of pronotum, mesothorax and metathorax heavily marked with fuscous. Pronotum narrower, its hind margin more produced. Hind femora intense cherry red apically within and beneath, shading into luteous at base. Hind tibiae very pale glaucous, distinctly annulate with deep black at base, infuscated beneath apically and at proximal third. Genitalia similar to those of *phoetaliotiformis*, the cerci a little slenderer, the sides of the subgenital plate, not fuscous but only slightly infumated.

One male, Needham, Mass., Aug. 23. Collection of A. P. Morse. Taken among the rank herbage of an abandoned upland field on gravelly loam. But a single specimen was found in spite of prolonged sweeping and several subsequent visits to the scene of its capture.

Named in honor of Thaddeus William Harris, the first entomologist to write on the orthoptera of Massachusetts.